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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

SMITH et al | Atty. Ref.: **124-838**

Serial No. **09/762,805** | Group: **2839**

Filed: **February 13, 2001** | Examiner: **M. Zarroli**

For: **FABRICATION OF OPTICAL WAVEGUIDES**

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APPEAL BRIEF

On Appeal From Group Art Unit 2839

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TABLE OF CONTENTS

I. REAL PARTY IN INTEREST

The real party in interest in the above-identified appeal is QinetiQ Limited by virtue of an Assignment of rights from the inventors to The Secretary of State for Defence recorded February 13, 2001, at Reel 11736, Frame 713, and a subsequent Assignment from The Secretary of State for Defence to QinetiQ Limited recorded February 20, 2002, at Reel 12831, Frame 459.

II. RELATED APPEALS AND INTERFERENCES

This is the second appeal with respect to the present application as, after Applicant's first Appeal Brief was filed, the Examiner issued the fourth non-final official action which is now currently being appealed.

III. STATUS OF CLAIMS

In the fourth non-final Official Action, Claims 1-12 are now rejected under 35 USC §112 (even though claim 8 is no longer pending) but with claims 4, 5 and 10-12 indicated as containing allowable subject matter and claims 1-3, 6, 7 and 9 are rejected under 35 USC §103. In the previous Appeal of the third non-final Official Action, claim 1 was the only rejected claim, with claims 11 and 12 allowed and claims 2-7, 9 and 10 objected-to.

IV. STATUS OF AMENDMENTS

No amendments have been submitted with respect to the claims as rejected in the fourth non-final Official Action.

V. SUMMARY OF THE INVENTION

The present invention relates generally to the fabrication of optical waveguides and specifically an optical waveguide with decreased propagation loss and decreased optical damage.

In the past, optical waveguides are known in which an optical fiber is provided where the core of the optical fiber and the surrounding optical material have different refractive indices. These differences provide a mechanism whereby light attempting to leave the core is "bent" back into the core either by diffraction or by reflection so as to maintain a high signal-to-noise ratio in the core.

Optical waveguides, rather than optical transmission fibers, are also known by bonding support structures and low refractive index layers on a glass substrate. Additionally, a benefit of direct bonding between layers is to decrease propagation loss and optical damage, thereby improving the transmission from optical waveguides. In such prior art optical waveguides, however, a flat lamina of material having a higher refractive index (forming the waveguide "core") is bonded between two lamina of material having a lower refractive index (forming a waveguide superstructure). Unfortunately, the large lateral dimension of such flat

"core" lamina meant that the arrangement was not useful for many waveguide applications or as a single-mode waveguide.

Appellants found that by using periodically poled lithium niobate (PPLN) or other similar material as the guiding lamina, the modified region on either side of an unmodified region of the guiding lamina is sufficient to maintain optical energy in a light guiding path. Specifically, appellants found that the use of direct interfacial bonding provided a sufficient bond between the guiding lamina and a superstructure lamina to then allow the guiding lamina to be machined down to a desired waveguide thickness. This strong mechanical and optical bond also provides low propagation loss for light traveling down the light guiding path. After proper machining of the guiding lamina, a second superstructure lamina can be bonded thereover, again by direct interfacial bonding, forming the desired optical waveguide.

Accordingly, the present invention is characterized by three layers: "**a guiding lamina of optical material bonded by direct interfacial bonding to a superstructure lamina of optical material**" and "**a second superstructure lamina bonded by direct interfacial bonding to the guiding lamina**," wherein "**the guiding lamina defines a light guiding path**" and "**the path is formed of an unmodified optical region of the guiding lamina**" and "**a modified optical region defines a boundary of the light guiding path.**"

VI. ISSUE

Whether claims 1-12 are not described in the specification as required by 35 USC §112 (1^{st} paragraph).

Whether claims 1-12 are indefinite under 35 USC §112 (2^{nd} paragraph).

Whether claims 1-3, 6, 7 and 9 are obvious over Booth in view of Beyea et al.

VII. GROUPING OF CLAIMS

The rejected independent claims 1 and 11 as well as all dependent claims stand and fall by themselves and each are specifically distinguished over the prior art as discussed in the argument portion of this Appeal Brief.

VIII. ARGUMENT

1. Discussion of the References

Booth et al (U.S. Patent 5,402,514) teaches an optical waveguide device with "photohardenable layers." Essentially the Booth disclosure utilizes a surface upon which layers of film are provided and a laser light source is used to expose a layer of film in order to create a guiding layer.

The Examiner admits that "Booth does not disclose that the light guiding path is the unmodified region and the modified region is the boundary of this path" and this admission is very much appreciated.

While in the fourth non-final Official Action the Examiner also suggests that he gives no patentable weight to the claimed interrelationship between claim elements, i.e. direct interfacial bonding (DIB), the Examiner does not indicate that Booth contains any teaching of DIB. In fact Booth, because it relates to the photoprocessing addition of film layers, certainly does not suggest DIB between these film layers, especially as defined in appellants' specification and as is well known to those of ordinary skill in the art.

Thus, Booth fails to contain any disclosure of any lamina bonded by direct interfacial bonding to another lamina, and as admitted by the Examiner, fails to teach a light guiding path which is an unmodified region and a modified region being the boundary of this path.

Beyea et al (U.S. Patent 5,804,461) teaches a method of fabricating a semiconductor laser device which includes a diode with one or more ion-implanted regions which is alleged to decrease the occurrence of dark-line defects.

It is noted that Beyea effectively shows that ion-implantation may be used in an inorganic semiconductor device to reduce refractive index (see column 4, lines 40-44). The Examiner suggests that Beyea discloses an optical waveguide with superstructure lamina and a light guiding path that is an unmodified region where the boundary of the light guiding path is a modified region and cites column 5, lines 29-39. However, a review of the cited portion does not appear to provide

support for the Examiner's conclusion that Beyea teaches the claimed optical waveguide.

2. Discussion of the Rejections

Claims 1-7 and 912 (there is no claim 8 pending) stand rejected under 35 USC §112 (1st paragraph) with the Examiner concluding that claims 1-12 are not described in the specification. To the extent the rejection is understood, the Examiner suggests that prior art shortcomings are not explained in the specification, that direct bonding or direct interfacial bonding is not explained in the specification and that there are "translation" errors in the specification.

Claims 1-7 and 9-12 (there is no claim 8 pending) are rejected under 35 USC §112 (2nd paragraph) as being indefinite. Again, to the extent understood, the Examiner appears to believe that direct bonding and direct interfacial bonding are different and thus the claims are unclear and in any event he gives these limitations little weight in distinguishing over the cited prior art.

Claims 1-3, 6, 7 & 9 are rejected under 35 USC §103 as unpatentable over Booth in view of Bayea. To the extent the rejection is understood, the Examiner appears to believe that Booth's disclosures of photoprocessed film layers comprise guiding lamina and superstructure lamina.

The Examiner admits that "Booth does not disclose that the light guiding path is the unmodified region and that the modified region is the boundary of this

path." However, the Examiner appears to suggest that Beyea discloses an optical waveguide where the light guiding path is the unmodified region while the boundary is the modified region.

Again, to the extent it is understood, the Examiner appears to believe that it would somehow be obvious to one of ordinary skill in the art to substitute the layers of Beyea for one of the film layers in Booth. It is also noted that the Examiner apparently ignores the claimed interrelationship between the lamina in appellants' independent claim 1, i.e. that they are bonded by "direct interfacial bonding."

Also, with respect to the required motivation for combining the Booth and Beyea references, the Examiner only concludes that because the combination provides benefits, the combination would be obvious (essentially taking the position that the benefit of any combination renders that combination obvious, even before the benefit is learned or understood).

3. The Errors in the Fourth Non-Final Rejection

There are at least five significant errors in the fourth non-Final Rejection and they are summarized as follows:

(a) No prior art reference teaches guiding lamina or superstructure lamina which are bonded by direct interfacial bonding;

(b) It is clear error for an examiner to ignore specifically claimed element interrelationships;

(c) There is no reason for combining references and in fact they are not combinable;

(d) Both references teach away from appellants' claimed combination of elements; and

(e) There is no defect under 35 USC §112.

(a) No prior art reference teaches guiding lamina or superstructure lamina which are bonded by direct interfacial bonding

Appellants' independent claims 1 and 11 positively recites three elements, i.e. a guiding lamina, a first superstructure lamina and a second superstructure lamina (and the method steps of providing these layers in the case of claim 11). Appellants' claims 1 and 11 also recite the interrelationship between pairs of these three elements, i.e. the guiding lamina and first superstructure lamina have a bond between them which is created by "direct interfacial bonding" and the guiding lamina and the second superstructure lamina have a similar bond between them. In order to render obvious appellants' claims 1 and 11, there must be a disclosure in one or more prior art references of all three of the elements and both of the two recited interrelationships between those elements in claim 1(and the consequent method steps in the case of claim 11).

Neither cited prior art reference contains any disclosure of direct interfacial bonding. There is certainly no disclosure of a guiding lamina and first and second superstructure lamina bonded thereon. As a result, there is clearly no basis for a rejection under 35 USC §103 because appellants' claimed elements and elemental interrelationships are not disclosed in the prior art.

(b) It is clear error for an examiner to ignore specifically claimed element interrelationships

In the fourth, non-final Official Action, the Examiner states that:

> "in regard to bonding the layers with direct interfacial bonding, the method of forming the device is a process limitation and not germane to the issue of patentability of the device itself. Therefore, this limitation has not been given patentable weight."

The above statement is a clear admission that the Examiner has failed to consider appellants' claimed interrelationship between claim elements. As appellants noted in the Background of the Invention, DIB or direct interfacial bonding provides a benefit, i.e. decreased propagation loss and decreased optical damage. Appellants' specification also notes that the use of a direct interfacial bond between the guiding lamina and the first superstructure lamina provides a bond strength between the guiding lamina and the superstructure lamina sufficient for the machining of the guiding lamina down to a small thickness, i.e. in a preferred embodiment, 12 microns (appellants' specification page 5, lines 6-9).

While this beneficial machining step is not recited in appellants' claim, it is the beneficial result of forming these structures by direct interfacial bonding relationship which is specified in the claims.

As a result, the Examiner has admitted error by failing to point out how or where any prior art reference teaches direct interfacial bonding and in particular direct interfacial bonding between appellants' claimed elements.

(c) There is no reason for combining references and, in fact, they are not combinable

Booth teaches the creation of film layers by photopolymerization and the use of a laser in order to effect such polymerization. Beyea teaches that ion implantation may be used in inorganic semiconductor devices to reduce refractive index (see Beyea column 4, lines 40-44). There is no disclosure by the Examiner of how or why one would used this aspect regarding an inorganic material to modify an organic material in the Booth device, thereby allowing Booth's light exposure step to be replaced by an ion-implantation step in order to achieve the claimed "light guiding path" of claims 1 and 11.

Moreover, as would be apparent to those of ordinary skill in the art, and as noted above, the material in Beyea is inorganic semiconductor material and the polymerized film layers in Booth are organic material. Why would one of ordinary skill in the art believe that these could be combined.

As a result, the combination of the Booth and Beyea teachings not only contain no suggestion to one of ordinary skill in the art for their combination, but in fact are not combinable to form any working device. As a result, the Examiner has failed to provide any *prima facie* basis for combining the teachings of the two prior art references, save for that disclosed in appellants' independent claims 1 and 11 and the current specification. The Examiner is prohibited from using such 20/20 hindsight.

(d) Both references teach away from appellants' claimed combination of elements

As noted above, the Booth reference suggests the use of polymerized films which are coated on top of other polymerized films. There is no suggestion for using guiding lamina or a superstructure lamina or direct interfacial bonding therebetween. In fact, Booth would lead one of ordinary skill in the art away from appellants' claimed requirement of direct interfacial bonding between the lamina and suggests instead that the same result can be achieved by photoprocessing. As a result, Booth would clearly lead one of ordinary skill in the art away from appellants' claimed invention.

Similarly, Beyea teaches that the guiding lamina should be inorganic material. Obviously, there is no suggestion in either reference of direct interfacial bonds between inorganic material of Beyea and the organic material of Booth as

recited in appellants' independent claims. As a result, Booth's and Beyea's teachings of organic and inorganic materials would lead one of ordinary skill in the art away from appellants' invention.

With respect to the rejection of claims 2 and 3, the Examiner admits that the combination of Booth and Beyea "does not disclose the claimed materials recited in these claims." Therefore, there is no prior art cited in support of the rejection of claims 2 and 3, nor is there any disclosure in the cited references of the materials recited in the claims.

The Examiner has provided no disclosure or reason why one of ordinary skill in the art would think to select ferroelectric material or lithium niobate to be the guiding lamina. As a result, the Examiner has not established a *prima facie* basis of obviousness of the subject matter of claims 2 and 3.

With respect to claim 6, the Examiner alleges that Booth teaches "indiffusion" of dopant materials at column 5, line 55. Booth actually discloses "interdiffusion" which causes an increase in the density of the exposed region, raising the refractive index and creating a "lens-like exposed region." The Examiner has not pointed out how or why he believes this "interdiffusion" creation of a "lens-like exposed region" discloses or renders obvious the "indiffusion" subject matter of appellants' claim 6.

With respect to claim 7, the Examiner alleges that Beyea discloses that "part of the modified region forms the light guiding path" but references only Figure 1 without any further disclosure. How or where in Figure 1 is there any disclosure of the modified region forming the light guiding path and how is this related to the subject matter of appellants' dependent claim 7? The Examiner has simply not set out a *prima facie* case for a rejection of claim 7.

Regarding claim 9, the Examiner suggests that Booth discloses a "means for launching an input signal optical signal into the waveguide." As is well-settled, claim 9 is in "means-plus-function" format and therefore the Examiner must first refer to appellants' specification for the corresponding structure and then, having identified that structure, demonstrate that that structure is shown in the Booth reference. The Examiner appears to have short-circuited this Federal Circuit claim analysis and merely jumped to the conclusion that Booth teaches the subject matter of claim 9. The Examiner has not properly set out a *prima facie* case of obviousness for claim 9.

Where both references teach away from appellants' combination of elements, there is certainly no basis for a rejection under 35 USC §103 as obvious.

(e) There is no defect under 35 USC §112

The Examiner rejects claims 1-7 and 9-12 under both the first and second paragraphs of 35 USC §112. Regarding paragraph 1, the Examiner apparently

misses the discussion on page 2, line 1 of applicants specification which indicates that the "shortcoming" of the prior art is the "large lateral dimension . . . [which] was not useful for many waveguiding applications or as a single-mode waveguide."

The Examiner also apparently misses the recitation of the definition of "direct bonding (or direct interfacial bonding)" as "a fabrication technique that uses the Van der Waals forces present when two atomically flat bodies approach each other to create a bond" (Specification, page 1, lines 5-8).

While the Examiner surmises that there appear "to be translation problems in the specification," he identifies no specific problem. It is noted that the PCT International application, and its GB priority document, were both filed in the English language.

Regarding the second paragraph basis for the alleged rejection of the claims under 35 USC §112, there is clearly no difference between direct bonding and direct interfacial bonding (see the above cited portion of the specification). Moreover, the term used in the claims has been defined in the specification. Therefore, even if it were not obvious to those of ordinary skill in the art (and the Examiner has not shown that it would not be obvious), the definition in the specification would control. The Examiner's adoption of the specification definition when he states that "the Examiner will interpret the term . . ." is exactly

what the Examiner is required to do (when a claim term is defined in a patent specification).

As a result, there is simply no basis for any rejection of claims 1-7 and 9-12 under 35 USC §112 and any further rejection is respectfully traversed.

IX. CONCLUSION

As discussed in detail above, no prior art reference discloses guiding lamina which are interconnected by direct interfacial bonding with superstructure lamina. The Examiner admits that he has ignored appellants' claimed interrelationship, i.e. direct interfacial bonding which has a beneficial result (although such benefit is not claimed, nor is there any requirement for the benefit to be claimed). The Examiner has provided no reason for combining cited elements of the two references, and indeed it would be difficult to combine the operations which are used in the organic Booth patent with the operations in the inorganic Beyea patent to form an optical waveguide nor would there be any reason for such combination. Finally, the Examiner apparently ignores the fact that both references would lead one of ordinary skill in the art away from appellants' unique and unobvious combination of elements. The alleged defects in the specification and claims under 35 USC §112 are simply not present as is readily apparent by a reading of the application.

In view of the above, the rejection of claims 1-7 and 9-12 are clearly in error and reversal thereof by this Honorable Board is respectfully requested.

Respectfully submitted,

NIXON & VANDERHYE P.C.

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SCS:kmm
Enclosures
Appendix A - Claim on Appeal

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APPENDIX A

Claims on Appeal

1. An optical waveguide comprising:

a guiding lamina of optical material bonded by direct interfacial bonding to a superstructure lamina of optical material, and

a second superstructure lamina bonded by direct interfacial bonding to the guiding lamina, the guiding lamina defining a light guiding path, wherein said path is formed of an unmodified optical region of the guiding lamina and a modified optical region defines a boundary of said path.

2. A waveguide according to claim 1, in which the guiding lamina is formed of a ferroelectric material.

3. A waveguide according to claim 2, in which the guiding lamina is formed of lithium niobate.

4. A waveguide according to claim 2, in which the modified regions are electrically poled regions of the guiding lamina.

5. A waveguide according to claim 4, in which the modified regions are spatially periodically electrically poled regions of the guiding lamina.

6. A waveguide according to claim 1, in which the modified regions are formed by indiffusion of one or more dopant materials into the guiding lamina.

7. A waveguide according to claim 1, in which at least part of the modified regions form the light-guiding path.

9. An optical parametric device comprising:

a waveguide according to claim 1; and

means for launching an input optical signal into the waveguide.

10. A device according to claim 9, comprising:

an output filter for filtering light emerging from the waveguide to reduce components having the wavelength of the input optical signal.

11. A method of fabricating an optical waveguide, the method comprising the steps of:

(a) bonding, by direct interfacial bonding, a guiding lamina (10) of optical material to a superstructure lamina of optical material;

(b) modifying optical properties of regions of the guiding lamina so as to define a light guiding path along the guiding lamina;

(c) removing material from the guiding lamina to reduce the thickness of the guiding lamina; and

(d) bonding, by direct interfacial bonding, a further superstructure lamina to the guiding lamina.

12. A method according to claim 11, further comprising:

before step (a), indiffusing and/or out-diffusing material to/from one face of the guiding lamina, that face being bonded to the superstructure lamina in step (a); and

before step (d), indiffusing and/or out-diffusing material to/from the exposed face of the guiding lamina, that face being bonded to the further superstructure lamina in step (d).

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The present invention relates generally to the fabrication of optical waveguides and specifically an optical waveguide with decreased propagation loss and decreased optical damage.

In the past, optical waveguides are known in which an optical fiber is provided where the core of the optical fiber and the surrounding optical material have different refractive indices. These differences provide a mechanism whereby light attempting to leave the core is "bent" back into the core either by diffraction or by reflection so as to maintain a high signal-to-noise ratio in the core.

Optical waveguides, rather than optical transmission fibers, are also known by bonding support structures and low refractive index layers on a glass substrate. Additionally, a benefit of direct bonding between layers is to decrease propagation loss and optical damage, thereby improving the transmission from optical waveguides. In such prior art optical waveguides, however, a flat lamina of material having a higher refractive index (forming the waveguide "core") is bonded between two lamina of material having a lower refractive index (forming a waveguide superstructure). Unfortunately, the large lateral dimension of such flat

"core" lamina meant that the arrangement was not useful for many waveguide applications or as a single-mode waveguide.

Appellants found that by using periodically poled lithium niobate (PPLN) or other similar material as the guiding lamina, the modified region on either side of an unmodified region of the guiding lamina is sufficient to maintain optical energy in a light guiding path. Specifically, appellants found that the use of direct interfacial bonding provided a sufficient bond between the guiding lamina and a superstructure lamina to then allow the guiding lamina to be machined down to a desired waveguide thickness. This strong mechanical and optical bond also provides low propagation loss for light traveling down the light guiding path. After proper machining of the guiding lamina, a second superstructure lamina can be bonded thereover, again by direct interfacial bonding, forming the desired optical waveguide.

Accordingly, the present invention is characterized by three layers: "**a guiding lamina of optical material bonded by direct interfacial bonding to a superstructure lamina of optical material**" and "**a second superstructure lamina bonded by direct interfacial bonding to the guiding lamina**," wherein "**the guiding lamina defines a light guiding path**" and "**the path is formed of an unmodified optical region of the guiding lamina**" and "**a modified optical region defines a boundary of the light guiding path.**"

VI. ISSUE

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While in the fourth non-final Official Action the Examiner also suggests that he gives no patentable weight to the claimed interrelationship between claim elements, i.e. direct interfacial bonding (DIB), the Examiner does not indicate that Booth contains any teaching of DIB. In fact Booth, because it relates to the photoprocessing addition of film layers, certainly does not suggest DIB between these film layers, especially as defined in appellants' specification and as is well known to those of ordinary skill in the art.

Thus, Booth fails to contain any disclosure of any lamina bonded by direct interfacial bonding to another lamina, and as admitted by the Examiner, fails to teach a light guiding path which is an unmodified region and a modified region being the boundary of this path.

Beyea et al (U.S. Patent 5,804,461) teaches a method of fabricating a semiconductor laser device which includes a diode with one or more ion-implanted regions which is alleged to decrease the occurrence of dark-line defects.

It is noted that Beyea effectively shows that ion-implantation may be used in an inorganic semiconductor device to reduce refractive index (see column 4, lines 40-44). The Examiner suggests that Beyea discloses an optical waveguide with superstructure lamina and a light guiding path that is an unmodified region where the boundary of the light guiding path is a modified region and cites column 5, lines 29-39. However, a review of the cited portion does not appear to provide

support for the Examiner's conclusion that Beyea teaches the claimed optical waveguide.

2. Discussion of the Rejections

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Claims 1-7 and 9-12 (there is no claim 8 pending) are rejected under 35 USC §112 (2^{nd} paragraph) as being indefinite. Again, to the extent understood, the Examiner appears to believe that direct bonding and direct interfacial bonding are different and thus the claims are unclear and in any event he gives these limitations little weight in distinguishing over the cited prior art.

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Also, with respect to the required motivation for combining the Booth and Beyea references, the Examiner only concludes that because the combination provides benefits, the combination would be obvious (essentially taking the position that the benefit of any combination renders that combination obvious, even before the benefit is learned or understood).

3. The Errors in the Fourth Non-Final Rejection

There are at least five significant errors in the fourth non-Final Rejection and they are summarized as follows:

(a) No prior art reference teaches guiding lamina or superstructure lamina which are bonded by direct interfacial bonding;

(b) It is clear error for an examiner to ignore specifically claimed element interrelationships;

(c) There is no reason for combining references and in fact they are not combinable;

(d) Both references teach away from appellants' claimed combination of elements; and

(e) There is no defect under 35 USC §112.

(a) No prior art reference teaches guiding lamina or superstructure lamina which are bonded by direct interfacial bonding

Appellants' independent claims 1 and 11 positively recites three elements, i.e. a guiding lamina, a first superstructure lamina and a second superstructure lamina (and the method steps of providing these layers in the case of claim 11). Appellants' claims 1 and 11 also recite the interrelationship between pairs of these three elements, i.e. the guiding lamina and first superstructure lamina have a bond between them which is created by "direct interfacial bonding" and the guiding lamina and the second superstructure lamina have a similar bond between them. In order to render obvious appellants' claims 1 and 11, there must be a disclosure in one or more prior art references of all three of the elements and both of the two recited interrelationships between those elements in claim 1(and the consequent method steps in the case of claim 11).

Neither cited prior art reference contains any disclosure of direct interfacial bonding. There is certainly no disclosure of a guiding lamina and first and second superstructure lamina bonded thereon. As a result, there is clearly no basis for a rejection under 35 USC §103 because appellants' claimed elements and elemental interrelationships are not disclosed in the prior art.

(b) It is clear error for an examiner to ignore specifically claimed element interrelationships

In the fourth, non-final Official Action, the Examiner states that:

> "in regard to bonding the layers with direct interfacial bonding, the method of forming the device is a process limitation and not germane to the issue of patentability of the device itself. Therefore, this limitation has not been given patentable weight."

The above statement is a clear admission that the Examiner has failed to consider appellants' claimed interrelationship between claim elements. As appellants noted in the Background of the Invention, DIB or direct interfacial bonding provides a benefit, i.e. decreased propagation loss and decreased optical damage. Appellants' specification also notes that the use of a direct interfacial bond between the guiding lamina and the first superstructure lamina provides a bond strength between the guiding lamina and the superstructure lamina sufficient for the machining of the guiding lamina down to a small thickness, i.e. in a preferred embodiment, 12 microns (appellants' specification page 5, lines 6-9).

While this beneficial machining step is not recited in appellants' claim, it is the beneficial result of forming these structures by direct interfacial bonding relationship which is specified in the claims.

As a result, the Examiner has admitted error by failing to point out how or where any prior art reference teaches direct interfacial bonding and in particular direct interfacial bonding between appellants' claimed elements.

(c) There is no reason for combining references and, in fact, they are not combinable

Booth teaches the creation of film layers by photopolymerization and the use of a laser in order to effect such polymerization. Beyea teaches that ion implantation may be used in inorganic semiconductor devices to reduce refractive index (see Beyea column 4, lines 40-44). There is no disclosure by the Examiner of how or why one would used this aspect regarding an inorganic material to modify an organic material in the Booth device, thereby allowing Booth's light exposure step to be replaced by an ion-implantation step in order to achieve the claimed "light guiding path" of claims 1 and 11.

Moreover, as would be apparent to those of ordinary skill in the art, and as noted above, the material in Beyea is inorganic semiconductor material and the polymerized film layers in Booth are organic material. Why would one of ordinary skill in the art believe that these could be combined.

As a result, the combination of the Booth and Beyea teachings not only contain no suggestion to one of ordinary skill in the art for their combination, but in fact are not combinable to form any working device. As a result, the Examiner has failed to provide any *prima facie* basis for combining the teachings of the two prior art references, save for that disclosed in appellants' independent claims 1 and 11 and the current specification. The Examiner is prohibited from using such 20/20 hindsight.

(d) Both references teach away from appellants' claimed combination of elements

As noted above, the Booth reference suggests the use of polymerized films which are coated on top of other polymerized films. There is no suggestion for using guiding lamina or a superstructure lamina or direct interfacial bonding therebetween. In fact, Booth would lead one of ordinary skill in the art away from appellants' claimed requirement of direct interfacial bonding between the lamina and suggests instead that the same result can be achieved by photoprocessing. As a result, Booth would clearly lead one of ordinary skill in the art away from appellants' claimed invention.

Similarly, Beyea teaches that the guiding lamina should be inorganic material. Obviously, there is no suggestion in either reference of direct interfacial bonds between inorganic material of Beyea and the organic material of Booth as

recited in appellants' independent claims. As a result, Booth's and Beyea's teachings of organic and inorganic materials would lead one of ordinary skill in the art away from appellants' invention.

With respect to the rejection of claims 2 and 3, the Examiner admits that the combination of Booth and Beyea "does not disclose the claimed materials recited in these claims." Therefore, there is no prior art cited in support of the rejection of claims 2 and 3, nor is there any disclosure in the cited references of the materials recited in the claims.

The Examiner has provided no disclosure or reason why one of ordinary skill in the art would think to select ferroelectric material or lithium niobate to be the guiding lamina. As a result, the Examiner has not established a *prima facie* basis of obviousness of the subject matter of claims 2 and 3.

With respect to claim 6, the Examiner alleges that Booth teaches "indiffusion" of dopant materials at column 5, line 55. Booth actually discloses "interdiffusion" which causes an increase in the density of the exposed region, raising the refractive index and creating a "lens-like exposed region." The Examiner has not pointed out how or why he believes this "interdiffusion" creation of a "lens-like exposed region" discloses or renders obvious the "indiffusion" subject matter of appellants' claim 6.

With respect to claim 7, the Examiner alleges that Beyea discloses that "part of the modified region forms the light guiding path" but references only Figure 1 without any further disclosure. How or where in Figure 1 is there any disclosure of the modified region forming the light guiding path and how is this related to the subject matter of appellants' dependent claim 7? The Examiner has simply not set out a *prima facie* case for a rejection of claim 7.

Regarding claim 9, the Examiner suggests that Booth discloses a "means for launching an input signal optical signal into the waveguide." As is well-settled, claim 9 is in "means-plus-function" format and therefore the Examiner must first refer to appellants' specification for the corresponding structure and then, having identified that structure, demonstrate that that structure is shown in the Booth reference. The Examiner appears to have short-circuited this Federal Circuit claim analysis and merely jumped to the conclusion that Booth teaches the subject matter of claim 9. The Examiner has not properly set out a *prima facie* case of obviousness for claim 9.

Where both references teach away from appellants' combination of elements, there is certainly no basis for a rejection under 35 USC §103 as obvious.

(e) There is no defect under 35 USC §112

The Examiner rejects claims 1-7 and 9-12 under both the first and second paragraphs of 35 USC §112. Regarding paragraph 1, the Examiner apparently

misses the discussion on page 2, line 1 of applicants specification which indicates that the "shortcoming" of the prior art is the "large lateral dimension . . . [which] was not useful for many waveguiding applications or as a single-mode waveguide."

The Examiner also apparently misses the recitation of the definition of "direct bonding (or direct interfacial bonding)" as "a fabrication technique that uses the Van der Waals forces present when two atomically flat bodies approach each other to create a bond" (Specification, page 1, lines 5-8).

While the Examiner surmises that there appear "to be translation problems in the specification," he identifies no specific problem. It is noted that the PCT International application, and its GB priority document, were both filed in the English language.

Regarding the second paragraph basis for the alleged rejection of the claims under 35 USC §112, there is clearly no difference between direct bonding and direct interfacial bonding (see the above cited portion of the specification). Moreover, the term used in the claims has been defined in the specification. Therefore, even if it were not obvious to those of ordinary skill in the art (and the Examiner has not shown that it would not be obvious), the definition in the specification would control. The Examiner's adoption of the specification definition when he states that "the Examiner will interpret the term . . ." is exactly

what the Examiner is required to do (when a claim term is defined in a patent specification).

As a result, there is simply no basis for any rejection of claims 1-7 and 9-12 under 35 USC §112 and any further rejection is respectfully traversed.

IX. CONCLUSION

As discussed in detail above, no prior art reference discloses guiding lamina which are interconnected by direct interfacial bonding with superstructure lamina. The Examiner admits that he has ignored appellants' claimed interrelationship, i.e. direct interfacial bonding which has a beneficial result (although such benefit is not claimed, nor is there any requirement for the benefit to be claimed). The Examiner has provided no reason for combining cited elements of the two references, and indeed it would be difficult to combine the operations which are used in the organic Booth patent with the operations in the inorganic Beyea patent to form an optical waveguide nor would there be any reason for such combination. Finally, the Examiner apparently ignores the fact that both references would lead one of ordinary skill in the art away from appellants' unique and unobvious combination of elements. The alleged defects in the specification and claims under 35 USC §112 are simply not present as is readily apparent by a reading of the application.

In view of the above, the rejection of claims 1-7 and 9-12 are clearly in error and reversal thereof by this Honorable Board is respectfully requested.

Respectfully submitted,

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SCS:kmm
Enclosures
Appendix A - Claim on Appeal

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APPENDIX A

Claims on Appeal

1. An optical waveguide comprising:

a guiding lamina of optical material bonded by direct interfacial bonding to a superstructure lamina of optical material, and

a second superstructure lamina bonded by direct interfacial bonding to the guiding lamina, the guiding lamina defining a light guiding path, wherein said path is formed of an unmodified optical region of the guiding lamina and a modified optical region defines a boundary of said path.

2. A waveguide according to claim 1, in which the guiding lamina is formed of a ferroelectric material.

3. A waveguide according to claim 2, in which the guiding lamina is formed of lithium niobate.

4. A waveguide according to claim 2, in which the modified regions are electrically poled regions of the guiding lamina.

5. A waveguide according to claim 4, in which the modified regions are spatially periodically electrically poled regions of the guiding lamina.

6. A waveguide according to claim 1, in which the modified regions are formed by indiffusion of one or more dopant materials into the guiding lamina.

7. A waveguide according to claim 1, in which at least part of the modified regions form the light-guiding path.

9. An optical parametric device comprising:

a waveguide according to claim 1; and

means for launching an input optical signal into the waveguide.

10. A device according to claim 9, comprising:

an output filter for filtering light emerging from the waveguide to reduce components having the wavelength of the input optical signal.

11. A method of fabricating an optical waveguide, the method comprising the steps of:

(a) bonding, by direct interfacial bonding, a guiding lamina (10) of optical material to a superstructure lamina of optical material;

(b) modifying optical properties of regions of the guiding lamina so as to define a light guiding path along the guiding lamina;

(c) removing material from the guiding lamina to reduce the thickness of the guiding lamina; and

(d) bonding, by direct interfacial bonding, a further superstructure lamina to the guiding lamina.

12. A method according to claim 11, further comprising:

before step (a), indiffusing and/or out-diffusing material to/from one face of the guiding lamina, that face being bonded to the superstructure lamina in step (a); and

before step (d), indiffusing and/or out-diffusing material to/from the exposed face of the guiding lamina, that face being bonded to the further superstructure lamina in step (d).